Audio-Facts

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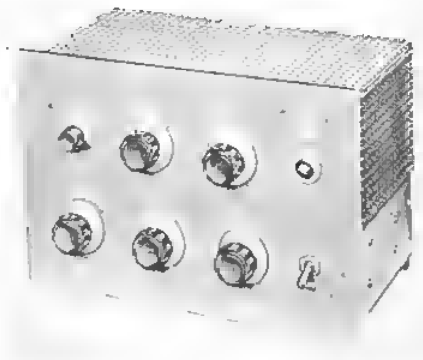
CONSTRUCTION DETAILS ABOUT A PREAMPLIFIER OF IMPROVED DESIGN

The preamplifier and control unit described in the "Audio Facts" column in the July-August 1952 issue of the PF INDEX and the original unit from which it was developed have been in constant use in our laboratory since they were constructed. They have given very consistent and satisfactory service with many different audio systems under widely differing conditions. In fact, we gain more respect for these useful pieces of equipment the more we use them in our increasing audio activities.

Three years are a long time in these days of rapid development in high quality audio systems; therefore, in order to keep up with progress, some changes and improvements have been made in both units. Taking a cue from the number of inquiries and comments which we continue to receive concerning the preamplifier and control unit, we feel that it would be worth while to supply some information about these improvements and some detailed data for those who would like to construct a unit.

A view of the preamplifier and control unit fitted with a perforated metal cover can be seen in the heading of this article. The general construction and features of the unit can be seen in Figs. 1 and 2. Enough switches, controls, and inputs are provided to permit flexibility of operation; but not enough are provided



to complicate the situation and make operation difficult rather than convenient.

The circuit of the complete unit, shown in Fig. 3, is made up of individual circuits that are mostly conventional and familiar. These individual circuits are effective and are worthy of some discussion before construction details are discussed.

Circuit Description

Any one of the three inputs can be switched into the circuit by the channel-selector switch. Input No. 1 is for use with magnetic phono pickups. Inputs No. 2 and No. 3 have the same characteristics. They are uncompensated and are intended for use with high-output devices such as tuners, TV receivers, crystal phono pickups, and tape recorders.

Input No. 1 connects directly to the grid (pin No. 7) of V1 which is a 12AT7 tube operating as a cascode amplifier. The cascode circuit is used because of its high gain, low noise, very high input impedance, and low input capacitance. These characteristics make it a logical input circuit for magnetic pickups because these normally have very low signal outputs and low output impedances. This application of the cascode circuit was discussed in more detail in "Audio Facts" in the April 1955 issue of the PF REPORTER.

R38 (which is shown by dotted lines in Fig. 3) is a loading resistor that is not needed in most cases but can be used if the high-frequency response of the pickup is excessive and if it must be rolled off. The resistance value of R38 can be the value recommended by the manufacturer of the magnetic cartridge being used. One of the best methods is to try different values until the best balance in response is obtained. For instance, it was found that a 27K-ohm, 1-watt resistor R38 reduced the high-frequency response by the correct amount when a General Electric RPX-050 cartridge was used. R38 was not used at all with a Fairchild Model 220 cartridge. R38 can be in-

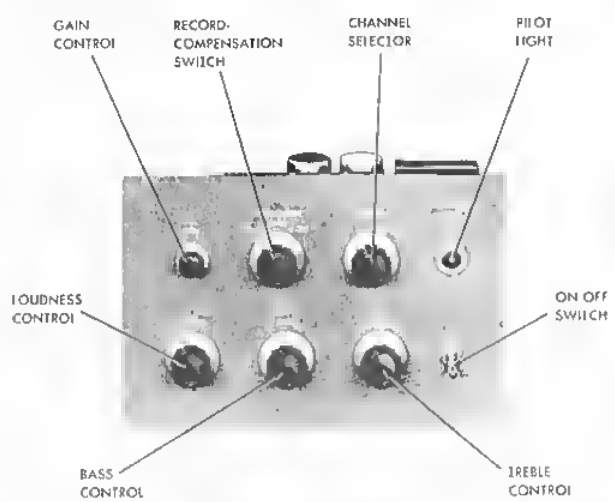


Fig. 1. Front View of Preamplifier and Control Unit.

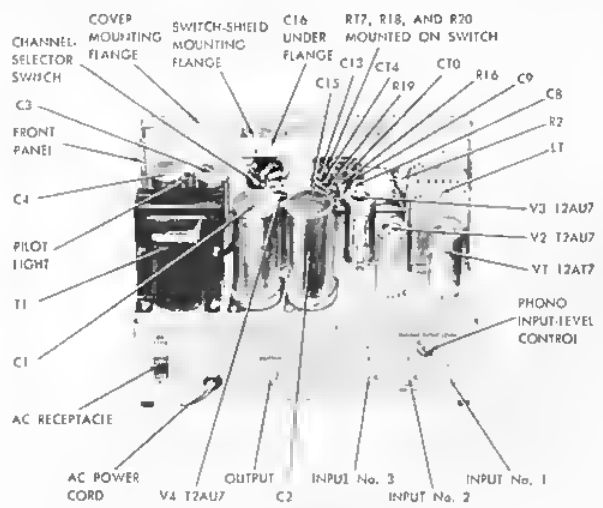


Fig. 2. Rear View of Preamplifier and Control Unit.

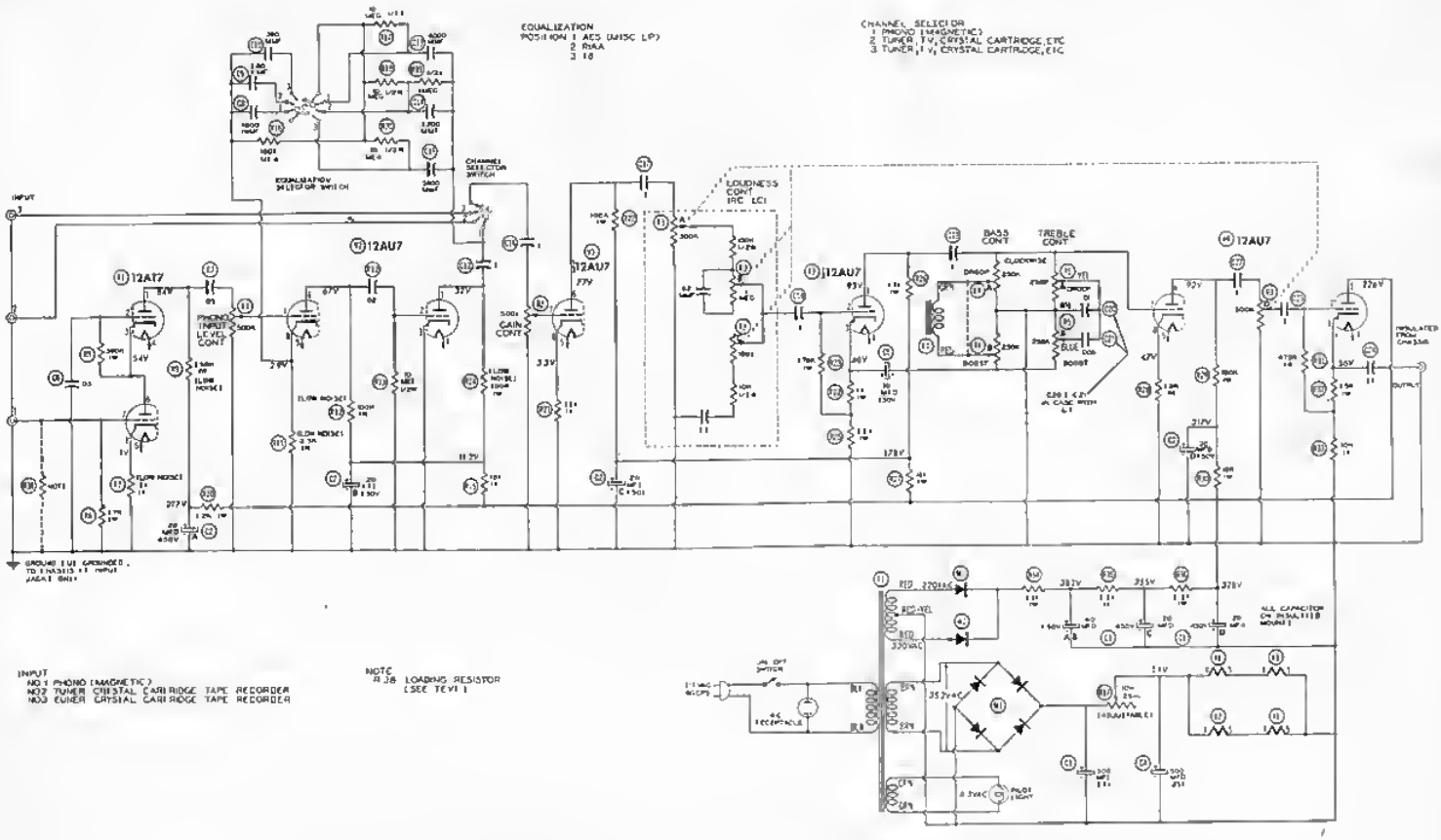


Fig. 3. Schematic Diagram of Preamplifier and Control Unit.

stalled either inside the chassis or in some convenient location on or close to the cartridge.

The phono input-level control R1 can be adjusted to provide a satisfactory operating level for any of the usual magnetic cartridges. Compensation for the characteristics of magnetic pickups and for record-playback curves is accomplished by the adjustable feed-back circuit which feeds back from the plate (pin No. 1) of V2 through C12 to the cathode (pin No. 8) of V2. Appropriate capacitors and resistors are switched into the feed-back circuit by the equalization-selector switch to provide bass boost and high-frequency roll-off according to three different playback curves.

Position No. 1, labeled AES (Audio Engineering Society), provides equalization based on a modification of the older AES curve and is suitable for use with many of the older micro-groove recordings. Position No. 2 follows the RIAA (Record Industry Association of America) curve, now considered the standard playback curve. This position is suitable for most recent microgroove recordings. Incidentally, the new AES, orthophonic, and NARTB (National Association of Radio and Television Broadcasters) curves are identical and are the same as the RIAA curve. Position No. 3 is a compromise and is intended to be used in playing 78-rpm records.

Any of these playback curves can be modified for best results by adjusting the treble and bass controls. It must be remembered that it is difficult to follow any particular recording curve when a recording is made and that conditions also make it difficult to play back a record according to a certain curve. Consequently, tone controls are useful for touching

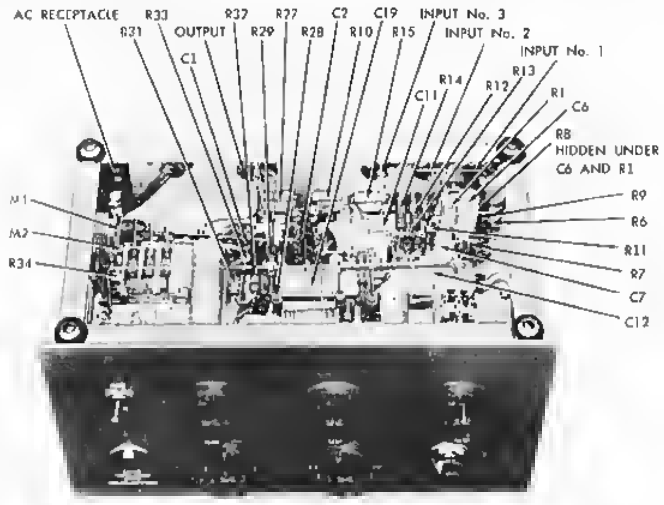


Fig. 4. Bottom View From Panel Side.

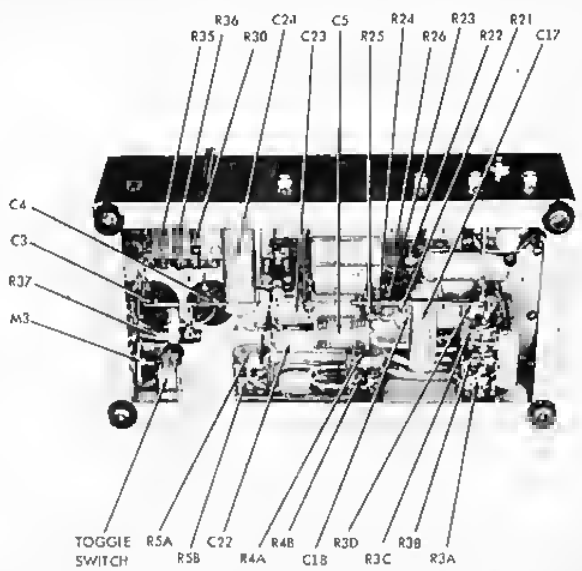


Fig. 5. Bottom View Showing Ports Located in Front Port of Chassis.

up the playback response in order to obtain the desired results.

The gain control R2, which operates on all input channels, is mounted on the front panel in a position convenient for setting the level of the signal fed to the loudness control. Some experimenting will reveal that the loudness control will produce the most pleasing balance between highs and lows when it is operated over a certain portion of its rotation. The gain control R2 is set to the position which permits the loudness control to operate within the correct range.

R3 is a standard IRC Type LC1 loudness control which has proved to be very satisfactory in maintaining balanced treble and bass response as the loudness level is varied. This control can be purchased as a complete assembled unit or can be made up from standard components.

The front section R3A of the loudness control is a 500K-ohm control (IRC stock No. Q11-133), the second section R3B is a 1-megohm multisection (IRC stock No. M13-137), and the third section R3C is a 100K-ohm multisection (IRC stock No. M13-128). A 10K-ohm half-watt resistor, a 100K-ohm half-watt resistor, an 82-mmfd ceramic capacitor, and a .03-mfd tubular capacitor are connected to the control as shown in the schematic diagram of Fig. 3.

In this preamplifier and control unit, a fourth section R3D which is a 500K-ohm multisection (IRC stock No. M11-133) is added to the loudness control and operates in the input of the output stage to reduce noise. The noise reduction which results from the action of this control is very pronounced, especially during the absence of a signal.

A Stancor C-2332-1 tone-control unit L1 and two dual 250K-ohm controls are used in a nonresonant LCR variable equalizer circuit. The insertion loss with this type of tone control circuit is not so high as the loss experienced with a circuit employing only capacitors and resistors. We have found this circuit to be one of the most stable ever used. In addition, it provides a wide range of bass and treble boost or droop.

With the dual bass control R4 in its maximum counterclockwise position, bass is attenuated because of the high resistance in the cathode circuit of the second section of V3 and because of the shunting of the low frequencies through L1 to ground in the grid circuit of the first section of V4.

When the bass control R4 is in the maximum clockwise position, the bass receives maximum boost because of the fact that the low reactance of L1 to low frequencies reduces the degeneration of low frequencies in the cathode circuit of the second section of V3. Furthermore, there is no loss of low frequencies in the grid circuit of the first section of V4 since L1 is, in effect, removed from the grid current.

With the dual treble control R5 in the maximum counterclockwise position, the high frequencies are given a maximum droop because of the shunting of the control section R5A by capacitors C20 and C21 and also because of the degeneration in the cathode circuit of the second section of V3.

Setting the treble control R5 to the maximum clockwise position results in maximum treble boost because of the shunting of control section R5B by capacitors C20 and C21. This shunting action reduces the degeneration of high frequencies in the cathode circuit of the second section of V3. In this position of the treble control, there is no capacitive shunting in the grid circuit of the first section of V4.

Any degree of boost or droop of the bass or treble between the extremes can be had by adjusting the appropriate control. This wide range is possible because of the dual action in the cathode circuit of the second section of V3 and because of the dual action in the grid circuit of the first section of V4. Such flexibility of control is very desirable when compensating for variations in program material and listening conditions.

The output stage (second section of V4) is a cathode follower and permits a long shielded cable to be used to connect the output of the unit

PARTS LIST

Tubes

V1	12AT2
V2	12AU7
V3	12AU2
V4	12AU2

Capacitors

	CAPACITANCE (mfd)	VOLTAGE (volts)	MALLORY	PYRAMID	SANGAMO	ERIE	CENTRALAB
C1A	20	450					
C1B	20	450					
C1C	20	450	FP444	TM-Q20-450	Q-040		
C1D	20	450					
C2A	20	450					
C2B	20	450	FP444	TM-Q20-450	Q-040		
C2C	20	450					
C2B	20	450					
C3	500	25	WP052	TM-500-25	S-040		
C4	500	25	WP052	TM-500-25	S-040		
C5	10	150	TC42	TD-10-150	MT-1512		
C6	.02	600	PT-615	IMP6-S5	220615		
C7	.05	600	PT-615	IMP6-S5	320615		
C8	1000	500	DC-521			GP2E-102	D6-102
C9	680	500	DC-5208			GP2K-681	D6-681
C10	390	500	DC-5339			GP2K-291	D6-291
C11	.02	600	PT-612	IMP6-S2	120612		
C12	.1	600	PT-601	IMP6-P1	220601		
C13	4000	500	VC-5240			GP2-222-402	D6-402
C14	2100	500	VC-5232			GP2-333-332	D6-222
C15	5000	500	VC-525			GP2-222-562	D6-562
C16	.1	600	PT-601	IMP6-P1	220601		
C17	.1	600	PT-601	IMP6-P1	220601		
C18	.1	600	PT-601	IMP6-P1	220601		
C19	.1	600	PT-601	IMP6-P1	220601		
C20	.01	In case with L1					
C21	.005	In case with L1					
C22	.1	600	PT-601	IMP6-P1	320601		
C23	.1	600	PT-601	IMP6-P1	220601		
C24	.25	600	PT-0025	IMP6-P25	3206022		

Controls

	RESISTANCE (ohms)	IRC	CLAROSTAT	CENTRALAB	MALLORY
R1	500K	Q12-123	A47-500K-2 1 KS-1/4 (shaft)	H60	U48
R2	500K	Q13-125	A47-500K-2 H5-2 (shaft)	H80	U48
R3		LC1			
R3A	500K	Q11-122			
R3B	1 meg	M12-137			
R3C	100K	M13-128			
R3D	500K	M11-133			
R4A	250K	Q12-130	DC-8-Z	B8-102	UT254A DS10 (shaft)
R4B	250K	M13-130			UB254A
R5A	250K	Q12-110	DC-8-Z	B8-103	UT254A DS16 (shaft)
R5B	250K	M12-110			UB254A

Resistors

	RESISTANCE (ohms)	WATTAGE RATING (watts)	IRC		RESISTANCE (ohms)	WATTAGE RATING (watts)	IRC
R6	42K	1	BTA 45K	R25	22K	1	BTA 22K
R7	2000	1	DCF 2000	R26	47K	1	BTA 47K
R8	560K	1	BTA 560K	R27	18K	1	BTA 18K
R9	250K	1	DCF 250K	R28	3900	1	BTA3900
R10	22K	1	BTA 22K	R29	100K	1	BTA100K
R11	2500	1	DCF 2500	R30	10K	1	BTA 10K
R12	100K	1	DCF 100K	R31	410K	1	BTA 410K
R13	10 meg	1/2	BTS 10 meg	R32	1500	1	BTA 1500
R14	100K	1	DCF 100K	R33	10K	1	BTA 10K
R15	18K	1	BTA 18K	R34	47	1	BW1-47 Wire wound
R16	100K	1	BTA 100K				
R17	10 meg	1/2	BTS 10 meg	R35	2200	1	BTA 2200
R18	10 meg	1/2	BTS 10 meg	R36	2200	1	BTA 2200
R19	1 meg	1/2	BTS 1 meg	R37	22	10	I 2/4 AA-25 Adjustable wire wound
R20	10 meg	1/2	BTS 10 meg				
R21	3900	1	BTA 3900				
R22	100K	1	BTA 100K	R38	Chosen by trial if required to roll off high-frequency response (see text)		
R23	410K	1	BTA 420K				
R24	1000	1	BTA 1000				

Selenium Rectifiers

	RADIO RECEPTOR	FEDERAL	MALLORY	SARKES TARZIAN	INTERNATIONAL
M1	HI 16Y1 or I2) 0T1	(2) 1153	(2) RS20	(2) 22	I2) CR20
M2	HI 18Y1 or I2) 4T1	(2) 1158	(2) RS20	(2) 25	I2) CR20
M2	PIBISIC	1016		204D	1D507G

Power Transformer

	STANCOR	PRIMARY	SECONDARY 1	SECONDARY 2	SECONDARY 3
T1	PC8412	115V AC	440V AC @ 50 ma DC	25.2V AC @ 5A	6.3V AC @ 6A

Tone Control Unit

L1	Stancor	C-2112-1

Miscellaneous

QUANTITY	
1	2-pole, 3-position switch (Centralab #1423; Mallory #1215L)
1	Single-pole, 2-position switch (Centralab #1401; Mallory #121L)
1	Single-pole, single-throw toggle switch
1	Pilot-light assembly
1	AC receptacle
5	9-pin octal tube socket
4	Phono jacks
1	AC power cord
1	Aluminum chassis, 5 by 10 by 2 inches
	Panel, terminal strips, miscellaneous hardware, etc.

to the input of a power amplifier without loss of high frequencies.

The power-supply section is similar to the supply discussed in detail in "Audio Facts" in the July 1954 issue of the PF REPORTER. Selenium rectifiers are used in conjunction with power transformer T1 to supply plate voltages and to furnish direct current to heat the tube filaments.

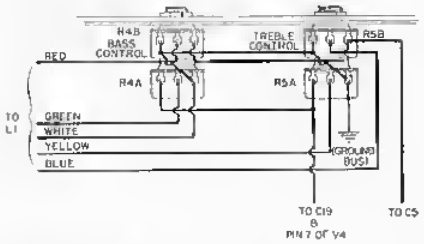


Fig. 6. Details for Correct Wiring of Bass and Trebie Cantrals.

Two selenium rectifiers M1 and M2 are employed to supply the plate voltages. Rectifiers M1 and M2 are 16Y1 Seletron units each of which is rated at 260 volts AC input and 20 milliamperes DC output. Two 8Y1 Seletron units (each rated at 130 volts AC input and 20 milliamperes DC output) or two of any listed in the Parts List can be connected in series and used for M1 or for M2. These units will handle the input voltage of 220 volts AC from the power transformer. Sections A and B of the four-section capacitor C1 are connected in parallel to provide 40 microfarads for the input capacitor of the filter.

A bridge type of selenium rectifier M3 is used in the DC heater supply. The full-wave output of the rectifier is filtered by the network composed of C3, C4, and R37. R37 is adjusted so that 24 volts DC are applied to the tube heaters which are connected in series parallel, as shown in the schematic diagram. Anyone who has never used direct current to heat tubes in low-level stages will be surprised to find how effective this type of supply can be in keeping hum at minimum. The 6.3-volt AC secondary is used only to light the pilot light.

Layout and Construction

The general layout of parts can be seen in the two bottom views of the unit shown in Figs. 4 and 5. Two views are used in order to show as many helpful details in layout and wiring as possible. Fig. 6 is included to show the correct method of wiring the bass and treble controls.

A ground bus, which connects to the chassis at the input jacks only, reduces the possibility of ground loops and is convenient to use when wiring the unit. All electrical grounds are made in progressive order on the ground bus. Shielded wires, with the shields grounded only at one end, are run to the input jacks and to the switches on the front panel. All electroylic capacitors and the output jack are mounted on insulated mounts.

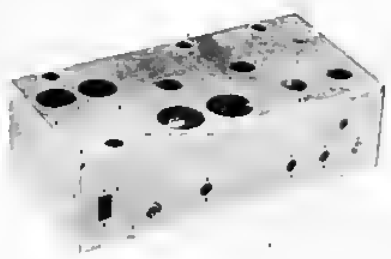


Fig. 7. Punched Chassis Before Parts Were Mounted.

The phono-input circuit and preamplifier section are arranged in a small area located as far away as possible from the rest of the circuits. The layout and wiring arrangement has proved to be very satisfactory with no interaction of circuits or unwanted feedback being detected at any time.

A photograph of the punched 5- by 10- by 3-inch aluminum chassis before any parts were installed is shown in Fig. 7. The locations of all large mounting holes are given in the drawings shown in Fig. 8. Since the locations of the small holes for the machine screws used to secure the parts to the chassis will depend upon the parts selected, no exact locations for these holes are indicated. Their general locations and the sizes of the drills with which they were drilled in this chassis are shown, however. Of course, the layout of parts can be changed to accommodate available components; but the arrangement shown has proved to be very satisfactory.

The front panel was cut from a standard 1/8-inch gray aluminum rack panel. It is secured to the chassis by the mounting nuts on the controls and on the ON-OFF switch. Decals made by the Tekni-Label Co., 732 S. Victory Blvd., Burbank, Cal., were applied to identify the controls and switches.

The cover, visible in the photograph in the heading of this article, was made from Reynolds perforated aluminum sheet. A sheet of paper can be folded, fitted to the unit, and used as a pattern to make a metal cover, if one is desired. A piece of sheet metal was cut and bent to serve as a mounting flange for the cover and for a small shield over the compensation and channel switches. Items such as the cover and switch shield should be tailored to fit the finished unit.

A parts list is included for those who wish to construct this useful piece of audio equipment.

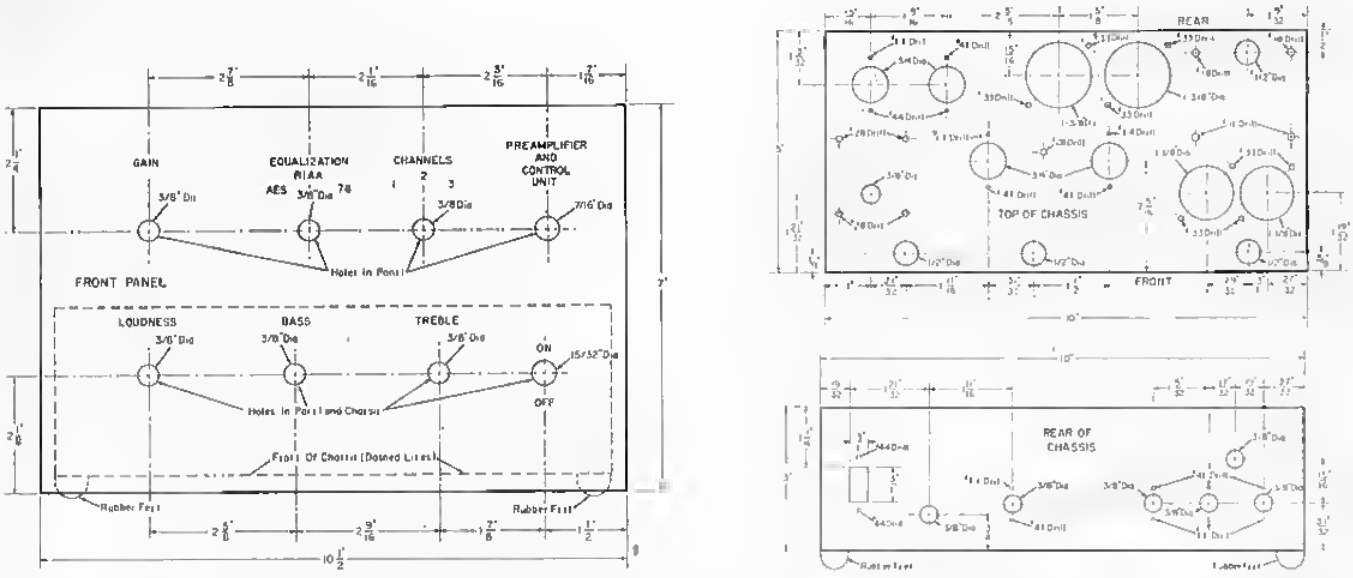


Fig. 8. Drawings Showing Locations of Holes in Chassis and Front Panel.